U.S. Environmental Protection Agency and U.S. Department of Homeland Security

WARRP Decon-13: Subject Matter Expert (SME) Meeting Waste Screening and Waste Minimization Methodologies Project

Final SME Meeting Report
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August 14 – 15, 2012

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The WARRP Decon-13 Subject Matter Expert (SME) Meeting, hosted by the U.S. Environmental Protection Agencys (EPAs) National Homeland Security Research Center (NHSRC), was held in Denver, Colorado, on August 14-15, 2012, at the Denver Animal Shelter (DAS). The purpose of the SME Meeting was to (1) identify existing technologies and methodologies that may help to minimize wastes, segregate waste streams, keep higher activity wastes separate from lower activity wastes, and, thereby, minimize cleanup and disposal costs, and (2) scope out what a draft standard operational guideline (SOG) might look like to assist in the cleanup and recovery of a wide-area RDD incident. The results from the SME Meeting were used to prepare a draft SOF to focus specifically on systems for waste segregation that provide personnel with information to implement waste minimization activities as part of an RDD response. The meeting brought together 30 participants, including SMEs in government (state and federal), the military (regional), and industry.

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Final SME Meeting Report

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U.S. Department of Homeland Security
WARRP Decon-13: Subject Matter Expert (SME) Meeting
Waste Screening and Waste Minimization Methodologies Project

U.S. Environmental Protection Agency
National Homeland Security Research Center
Decontamination and Consequence Management Division
Research Triangle Park, NC

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Disclaimer

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronyms

AFB	Air Force Base
ALARA	as low as reasonably achievable
CBR	chemical, biological, or radiological
CFR	Code of Federal Regulations
DAS	Denver Animal Shelter
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
HEPA	high efficiency particulate air
IBRD	Interagency Biological Restoration Demonstration
ICS	Incident Command System
INL	DOE Idaho National Laboratory
LLRW	Low Level Radioactive Waste
NHSRC	National Homeland Security Research Center
NRC	Nuclear Regulatory Commission
ORCR	Office of Resource Conservation and Recovery
ORIA	Office of Radiation and Indoor Air
PAGs	Protection Action Guides
RCRA	Resource Conservation and Recovery Act
RDD	Radiological Dispersal Device
SGS	Segmented Gate System
SME	subject matter expert
SOG	standard operational guideline
UASI	Urban Area Security Initiative
USDA	United States Department of Agriculture
WAC	waste acceptance criteria
WARRP	Wide Area Recovery and Resiliency Program

Abbreviations

m^3	cubic meter(s)
Cs	cesium
Ci	Curie
km	kilometer(s)
mrem	millirem(s)
mSv	millisievert(s)
pCi/g	picocurie(s) per gram
Sv	sievert
yd^3	cubic yard(s)

1. INTRODUCTION

The U.S. Department of Homeland Security (DHS), in close coordination with the U.S. Environmental Protection Agency (EPA), the U.S. Department of Defense (DoD), the U.S. Department of Energy (DOE), the U.S. Department of Health and Human Services (HHS), and the Denver Urban Area Security Initiative (UASI), has initiated the Wide Area Recovery and Resiliency Program (WARRP). WARRP is designed to develop guidance to support the recovery of a large urban area (specifically, Denver) following a chemical, biological, or radiological (CBR) wide-area incident. One program activity completed under WARRP was the WARRP Systems Study. This study identified 25 key gaps, including the lack of waste minimization polices, processes, and technologies, particularly highlighted for wide-area Radiological Dispersal Device (RDD) scenarios. Specifically, the amount of waste generated from an RDD that requires low-level radioactive waste (LLRW) disposal needs to be minimized by employing screening techniques and properly segregating different types of waste. Project "Decon-13" represented the effort to identify options for minimizing waste from an RDD.

The WARRP Decon-13 Subject Matter Expert (SME) Meeting, hosted by the U.S. Environmental Protection Agency's (EPA's) National Homeland Security Research Center (NHSRC), was held in Denver, Colorado, on August 14-15, 2012, at the Denver Animal Shelter (DAS).

The purpose of the SME Meeting was to (1) identify existing technologies and methodologies that may help to minimize wastes, segregate waste streams, keep higher activity wastes separate from lower activity wastes, and, thereby, minimize cleanup and disposal costs, and (2) scope out what a draft standard operational guideline (SOG) might look like to assist in the cleanup and recovery of a wide-area RDD incident. The results from the SME Meeting will be used to prepare a draft SOG to focus specifically on systems for waste segregation that provide personnel with information to implement waste minimization activities as part of an RDD response.[1]

The meeting brought together 30 participants, including SMEs in government (state and federal), the military (regional), and industry. The meeting agenda was structured to allow formal presentations from SMEs on Day 1 before lunch. Time was allocated after lunch to allow identification, discussion, and criteria development for waste segregation technologies. These criteria were used the second day to rank the most promising technologies. The final topic of Day 2 was to discuss the outline of the SOG.

This report summarizes remarks made during the SME Meeting. The intent of this final report is to provide a list of the meeting participants, an overview of the presentations, and a summary of the discussions and specific conclusions. This final report also incorporates feedback from SMEs who reviewed the draft summary report.

[1] Waste segregation and minimization are components of waste management. The purpose of the SOG will be to provide non-prescriptive guidelines and information on existing technologies and methodologies that enhance cleanup and reduce waste and/or waste management costs from an RDD incident.

This SME Meeting report is organized as follows:

- Section 1 – Introduction
- Section 2 – Summary of Day 1 discussions
- Section 3 – Summary of Day 2 discussions
- Appendix A – Final list of participants
- Appendix B – PowerPoint slides from the presentations.

The two-day meeting consisted of a series of presentations by various personnel from federal agencies and state offices and by independent consultants. The following agenda lists the specific sessions, the presenters, and their respective affiliations.

Denver Animal Shelter - Community Room Tuesday, August 14, 2012: 8:00 a.m. - 4:30 p.m. MST		
8:00 – 8:15 a.m.	Welcome	Paul Lemieux, Ph.D., EPA, NHSRC
8:15 – 8:30 a.m.	Introductions/Objectives	Rachel Sell, Battelle, Facilitator
8:30 – 9:00 a.m.	Opening Remarks	Garry Briese, Briese & Associates, LLC
9:00 – 9:30 a.m.	Waste Stream Characterization/How to Scope out the Problem	Bill Steuteville, EPA, Region 3
9:30 – 10:00 a.m.	Waste Management Organizational Structure	Eugene Jablonowski, EPA, Region 5
10:00 – 10:15 a.m.	Break	
10:15 – 10:45 a.m.	Radiological Dispersal Device – Case Studies	Ed Tupin, EPA, Office of Radiation and Indoor Air (ORIA)
10:45 – 11:15 a.m.	WARRP 101	Peter VanVoris, Ph.D. VanVoris and Associates, LLC
11:15 – 11:45 a.m.	Waste Segregation Issues Facing State and Local Governments	Dave Erickson, Denver Environmental Health
11:45 – 1:00 p.m.	Lunch	

Denver Animal Shelter - Community Room Tuesday, August 14, 2012: 8:00 a.m. - 4:30 p.m. MST (cont'd)		
1:00 – 2:30 p.m.	Segregation Technologies • Preliminary Results from Literature Review • Additional Technologies to Consider • Discussion of Technology Features	Rick Demmer, DOE Idaho National Laboratory (INL) Discussion facilitated by Rachel Sell
2:30 – 2:45 p.m.	Break	
2:45 – 4:15 p.m.	Criteria for Evaluation of Segregation Technologies • Review Draft Criteria List • Suggestions for Additional Criteria to Consider • Weighting of Criteria • Finalize Criteria List	Rick Demmer Discussion facilitated by Rachel Sell
4:15 – 4:30 p.m.	Wrap Up – Review Expectations for Day 2	Rachel Sell
Wednesday, August 15, 2012: 8:00 a.m. - 12:00 p.m. MST		
8:00 – 8:15 a.m.	Welcome	Paul Lemieux
8:15 – 10:00 a.m.	Rank Technologies Against Finalized Criteria	All (discussion facilitated by Sell)
10:00 – 11:30 a.m.	Standard Operational Guideline • Preliminary Outline • Discussion of Content	Rachel Sell All (discussion facilitated by Sell)
11:30 – 11:45 a.m.	Discussion of Path Forward	Rachel Sell
11:45 – Noon	Closing Remarks	Paul Lemieux
	Adjourn Meeting	

2. SUMMARY OF DAY 1, AUGUST 14, 2012

Welcome
Paul Lemieux, Ph.D., EPA, NHSRC

Dr. Lemieux welcomed the SME Meeting participants and expressed his appreciation for their willingness to spend time to attend and participate in the meeting. He provided a brief overview

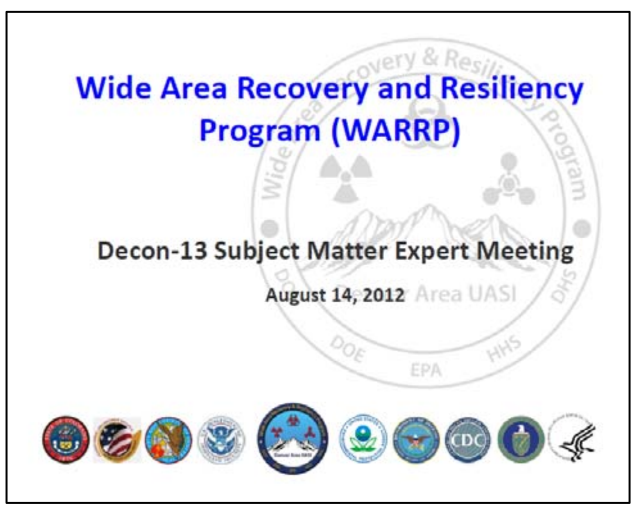
of the Waste Screening and Waste Minimization Methodologies Project (hereinafter: Waste Screening project), explained its relevance to WARRP, and described how EPA is involved in the effort. He explained that the Waste Screening project involves the development of a SOG for adapting existing equipment, techniques, and regulations to facilitate waste segregation and minimization activities during an RDD incident. Dr. Lemieux said waste minimization can be achieved by identifying waste that has activity below a level set by decision-makers that would allow it to be sent to a non-LLRW disposal facility, such as a Resource Conservation and Recovery Act (RCRA) Subtitle C or Subtitle D facility, or even be recycled.

Introductions/Objectives
Rachel Sell, Battelle

Ms. Sell greeted meeting participants and provided an overview of logistics for the meeting. Ms. Sell then requested that participants introduce themselves, identify their affiliation, and describe their role(s) related to radiologically contaminated waste and debris. Ms. Sell thanked participants in advance for their input and noted that SME input is an integral piece of the process for identifying radiological waste screening technologies and helping to scope out what guidelines should look like as part of an RDD response. She provided a quick overview of the two-day agenda. She noted that the first half of Day 1 would be dedicated to presentations and the afternoon would focus on open discussion.

Ms. Sell then introduced Frank Boldoe from the Denver Department of Environmental Health's Animal Care and Control Division, who provided an overview of the meeting's venue, the DAS. Mr. Boldoe explained that the DAS is Platinum-certified under the U.S. Green Building Council's Leadership in Energy and Environmental Design program, making DAS the first and only animal facility in the country to achieve this nationally recognized environmental rating from the council. Finally, Ms. Sell acknowledged Garry Briese for his assistance in securing the venue for the SME Meeting and introduced him as the first speaker.

Opening Remarks
Garry Briese, Briese & Associates, LLC



Mr. Briese serves as the Local Program Integrator for WARRP for the Denver Urban Area Security Initiative (UASI). He described the efforts being undertaken as part of the Denver UASI. He said their efforts and focus have been related to speed, notably the speed of recovery to the economy. Dr. Briese said that even efforts geared toward response always lead back to recovery (mitigation, preparedness, and response are the first three steps in recovery). He noted that whether it's a Fukushima type incident, the DHS Planning Scenario 11, or another chemical/biological attack, the speed (or "what will allow us to move fastest") at which recovery occurs is of primary

concern. Dr. Briese also offered perspective on planning for simultaneous responses and being mindful that "unexpected" events often "are still somewhat predictable." For instance, he said that the Fukushima nuclear incident was not caused by the earthquake or tsunami, but rather by the placement of the generators. He discussed this in terms of recognizing "Black Swan" events that can lead to huge failures, yet may still be quantified statistically. A black swan is a highly improbable event with three principal characteristics: it is unpredictable; it carries a massive impact; and, after the fact, an explanation is concocted that makes it appear less random, and more predictable, than it was.[2] Mr. Briese concluded by reviewing upcoming WARRP-related activities and events (e.g., September 13-14 Capstone) and other working group meetings. He also noted that local participants and stakeholders have contributed more than 10,000 hours of support to the success of WARRP.

Waste Stream Characterization/How to Scope out the Problem
Bill Steuteville, EPA, Region 3

Mr. Steuteville described the WARRP RDD scenario, which involved two simulated RDD attacks: one at the U.S. Mint in downtown Denver, Colorado, and another at the Anschutz Medical Campus in Aurora, Colorado. The scenario assumes that tens of thousands of people are exposed and that hundreds die from blast-related trauma, not radiation. The primary fallout area is within tens of miles of the blast although some of the radiological agent may be carried hundreds of miles. The downtown release scenario potentially impacts more than 20 square miles, 32,000 buildings, and 82 million square feet of indoor space, while the Aurora release scenario impacts fewer buildings and people but contaminates a much larger area. Both bombs were identical but the difference in the plumes is due to the entrainment of contamination by the high-rise downtown Denver buildings. In the downtown Denver scenario, higher concentrations of Cesium-137 (Cs-137) were deposited immediately around and downwind of the blast. In the Aurora scenario, the cesium was spread out over a far larger area.

Mr. Steuteville said that the model used to simulate the contaminant deposition from the incident calculates in three dimensions and that web-based tools were used to estimate building contents, outdoor areas, decontamination waste, and demolition waste. Tools were used to estimate the waste to an order of magnitude, including the Waste Estimation Support Tool, Incident Waste Assessment & Tonnage Estimator Tool, and preliminary results from the Bio-Response Operational Testing and Evaluation Program, specifically the personnel decontamination waste generation data. The types of radiological waste that would be generated include a variety of liquid and solid wastes, the vast majority of which will be Class A LLRW with minimal levels of

[2] The Black Swan theory was formulated by Nassim Taleb in his 2007 book, The Black Swan: The Impact of the Highly Improbable.

contamination. Waste class A is defined in Nuclear Regulatory Commission (NRC) regulations at Title 10 Part 61.55 of the Code of Federal Regulations (CFR), Waste Classification, and 10 CFR 61.56, Waste Characteristics. Class A waste is waste that is usually segregated from other waste classes at the disposal site.[3] Mr. Steuteville said such a scenario can generate a substantial amount of liquid waste, estimated to be in the range of 1.5 to 3 billion gallons, equal to 50,000 to 100,000 railroad tank cars (30,000-gallon capacity) or 275,000 to 550,000 tanker trucks (5,500-gallon capacity). He said the amount of solid waste generated in an RDD incident is also significant. Solid waste estimates can approach 16 million to 21 million tons, equal to 160,000 to 210,000 railroad hopper cars (100-ton capacity), 400,000 to 525,000 semi-trailers (64,000-pound net capacity), or 500,000 to 656,000 tri-axle dump trucks.

Mr. Steuteville then compared the WARRP RDD scenario with EPA's Liberty RadEx exercise, an RDD scenario based in Philadelphia, Pennsylvania. He described the scenario, the relocation and cleanup areas, and how various factors (e.g., selection of various decontamination technologies, cleanup levels/strategies) are related to the type and amount of waste generated.

Decontamination technologies tested during Liberty RadEx included cleaning agents (e.g., acids, foams, and strippable coatings), which reduce radiation but do not eliminate it. These technologies are most likely used in areas of lower contamination for initial cleaning to quickly open critical infrastructure and mobilize key resources, and for areas with limited exposure. Cleanup strategies used by Liberty RadEx players for planning wide-area cleanup in areas of significant contamination included roof replacement; soil removal; street and sidewalk surface removal; disposal of carpets, furnishings, possessions, and drywall; and building demolition in the case of higher contamination. Philadelphia citizens were included in the exercise, and after reviewing the scenario and the numerous decisions that had to be made, the citizens favored their own cleanup prioritization. The citizens wanted a two-pronged approach to cleanup, with simultaneous cleanups beginning: (1) around the Liberty Bell and the downtown business district, and (2) where, under the Liberty RadEx scenario, people were not relocated as part of the response but were still living with the contamination until their properties were cleaned.

Mr. Steuteville also stressed that as part of an RDD scenario, cleanup cannot proceed without decisions regarding waste handling options and will be prohibitively costly and slow without local waste disposal or staging solutions. In addition, he said state leadership, including cleanup criteria, waste disposal, and community involvement, is essential.

He said the idea is not for EPA to impose itself on states, but rather, assuming EPA support is needed, the agency would work with the local incident command and state and local officials to aid in the response and cleanup.

Waste Management Organizational Structure
Eugene Jablonowski, EPA, Region 5

Mr. Jablonowski provided an overview of Incident Command System (ICS). He explained that ICS is a standardized, on-scene, all-hazards incident management approach allowing its users to

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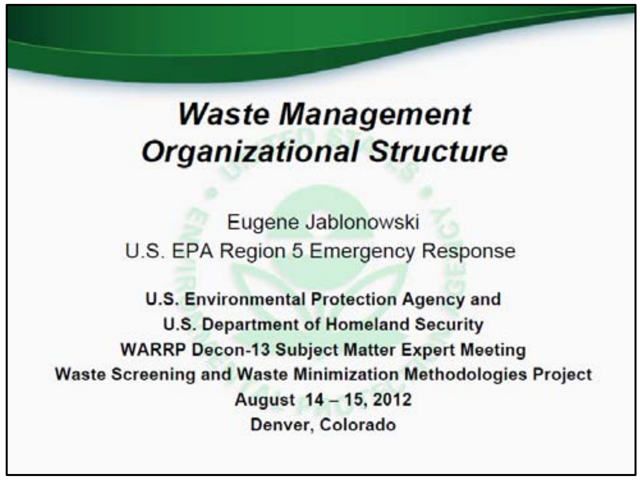
[3] Class A waste classification is available at: http://www.nrc.gov/reading-rm/doc-collections/cfr/part061/part061-0055.html.



adopt an integrated, yet flexible, organizational structure to match the complexities and demands of single or multiple incidents. An ICS allows facilities, equipment, personnel, procedures, and communications to be integrated and operated within a common organizational structure. The ICS enables a coordinated response among various jurisdictions and public and private agencies, as well as establishing a common process for planning and managing resources. Mr. Jablonowski noted that an ICS is typically structured to facilitate activities in five major functional areas: (1) Command, (2) Operations, (3) Planning, (4) Logistics, and (5) Finance/Administration (Intelligence/Investigations is an optional sixth functional area).

Mr. Jablonowski explained that EPA Regions 3, 4, and 5 developed an approach to RDD response as part of a national planning exercise to meet national homeland security goals. The exercise identified EPA resources, gaps, and other issues requiring more development (regional and nationwide). This approach improves EPA's preparedness to respond to an RDD event and multiple "incidents of national significance." The approach was exercised at Liberty RadEx.

Mr. Jablonowski then described several organizational charts that depicted an approach to staffing a response. The charts were organized by a command group, including anticipated areas of state and local personnel to assist in staffing, as well as several operation groups that were then organized into various branches. Examples of the overarching branches included: (1) assessment, (2) cleanup, (3) environmental monitoring, (4) health and safety implementation, and (5) waste management. For example, the Waste Management Branch is responsible for collecting, storing, characterizing, documenting, shipping, and/or treating all wastes generated or collected on-site during recovery activities, including radiological waste, solid wastes, liquid wastes, and other hazardous materials and nonhazardous wastes generated by recovery activities. Additional organizational charts Mr. Jablonowski described included planning and logistics groups. The planning group included such subgroups as a data and modeling interpretation team, response and cleanup technologies specialists, and an ecological and health assessment team. The logistics group was comprised of subgroups such as communications, information technology support, security, medical, housing, and food.

Mr. Jablonowski concluded by presenting several waste management tactics and disposal options to support an approach for an RDD response. During the early phase, waste management will likely consist of supporting first responders by removing debris to support life-saving missions. Quick identification of interim sites to temporarily store contaminated waste and debris may be necessary. Early identification of disposal facilities and determination and establishment of waste acceptance criteria (WAC) for disposal facilities will be imperative. From there, facility-specific WAC information would be used to plan for waste sampling/characterization, packaging, transportation, etc.

Regarding disposal options, Mr. Jablonowski said all options would need to be addressed with the impacted state and the receiving states, if different. Currently, there are no disposal criteria that exist to utilize RCRA facilities for RDD radionuclides, but methods are currently available for their development. It may be advantageous to implement a “balanced approach” for waste disposal where smaller volumes of higher-activity waste are disposed off-site at an existing federal disposal site, or at commercial licensed/permitted disposal facilities, while larger volumes of lower-activity waste are disposed at either an existing RCRA Subtitle C disposal facility near the site, or at an incident-specific Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) disposal facility designed to meet the criteria for RCRA Subtitle C hazardous waste disposal, the NRC Part 61 requirements for land disposal of radioactive waste, and any other applicable or relevant and appropriate requirements (ARARs). He noted that some sort of hazardous and mixed waste management also may be needed, depending on the incident location and impacted buildings/areas (e.g., radiation-contaminated asbestos-containing material).

Radiological Dispersal Device – Case Studies
Ed Tupin, EPA, ORIA

Mr. Tupin provided a detailed overview of several scenarios with characteristics similar to those anticipated with an RDD, beginning with a discussion of the March 2011 earthquake and tsunami in Japan. The earthquake knocked out the electrical distribution systems at the Fukushima Daiichi nuclear power plant, the tsunami flooded the backup generators, resulting in a total loss of cooling systems and instrumentation and eventually leading to core meltdown. It appears now that spent fuel stored in pools was not damaged, which otherwise could have made the situation much worse. The damage to the Fukushima Daiichi reactors was classified as a Level 7 – “Major Accident” on the International Nuclear Event Scale (“A major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures”). Mr. Tupin said there is still not a consensus regarding the amount of radioactive material released, or how the released radioactive material compares to Chernobyl. In looking at atmospheric releases of Cs-137, there seems to be agreement that Fukushima releases were about 10 to 20% of those produced by the Chernobyl event. However, the Fukushima event has resulted in significant releases of contaminated water to the ocean. Also, the Chernobyl releases occurred over about 10 days, while releases from Fukushima continued over a longer period of time. Mr. Tupin described additional radionuclides (e.g., Iodine-131) that were released and how their releases and deposition impacted evacuation. Evacuation extended out to 20 kilometers (km), with restricted entry extending to 30 km. More than 150,000 people were evacuated, of which approximately 100,000 are still displaced. Many will not be able to return for years.

Mr. Tupin said two radionuclides are driving long-term cleanup: Cs-137 (30-year half-life) and Cs-134 (2-year half-life). Cesium can present a problem for decontamination because it tends to bind to surfaces over time. In some cases, this binding to surfaces can be an advantage, because if cesium binds to the upper layers of soil, simple removal of those layers of soil may be effective. Cesium is not generally very mobile in the subsurface. Iodine-131 (8-day half-life) was not a concern in the long term (short half life, decayed away).

Mr. Tupin said the management of radioactive waste was significantly complicated by the aftermath of the earthquake and tsunami. Everything essentially becomes a waste stream, and much of the waste stream is mixed together, presenting a much more challenging task. Areas to the west of Fukushima, which host agricultural activities, may have to be taken out of cultivation for years. He said one should keep in mind the difference between the wastes being generated at the nuclear plant itself and the wastes being generated in areas affected by fallout. Plant operators have generated large amounts of waste consisting of filtering/absorbing media (e.g., zeolites) that have been used to try to remove radionuclides from water that is being released to the ocean.

Mr. Tupin stated that the government of Japan has developed prioritized cleanup areas, including schools and other child-sensitive areas as well as agricultural production areas. The government has stated its goal to reach levels of 100 millirem (mrem) to 2 rem per year (1 millisievert [mSv] to 20 mSv per year) as a bench mark for restoration. He said that, in prioritizing the cleanup areas, those with levels above 5 rem per year (which is also a U.S. occupational standard) have initially been seen as too contaminated to address effectively in the near term. Many areas are significantly above that level. If local officials or residents want to clean up areas that now are below 100 mrem, they are expected to handle that themselves. Reaching these levels (i.e., 100 mrem per year or lower) will be an iterative process and will likely take years to achieve.

Mr. Tupin also described the roadmap for special decontamination projects underway and a timeline for anticipated completion. The aim of these decontamination projects is to serve as demonstrations of techniques that apply to different types of circumstances – e.g., roads, farmlands, woodlands. A temporary LLRW storage site is being planned to facilitate cleanup. The facility will be capable of storing ~280 million tons by 2015. There has been resistance from local communities/officials who want assurance that the facilities will not be permanent. The government continues to look at the need for both short-term (~3 years) and long-term (~30 years) storage.

Mr. Tupin said that while the scale of the Fukushima accident likely exceeds the impacts from an RDD attack, several aspects are relevant: (1) cleanup goals will affect the volumes of waste generated; (2) decontamination strategies will also affect waste volumes; (3) there is likely to be public pressure to accelerate cleanup (e.g., prioritizing certain areas like schools); (4) federal, state, and local roles and responsibilities for decision-making on cleanup and waste management may create tension (i.e., local management of waste will be expected); and (5) the initial focus will be on waste staging and temporary and longer-term interim storage (disposal likely will take more time).

Mr. Tupin said that in the event of an RDD attack, a theme that comes up often is “shared sacrifice” in managing large waste volumes. That is, other states will be more likely to accept some amount of waste in a national emergency if the state (or states) where the incident occurs shows a willingness to manage the waste as well. This type of decision would need to be made by state and local officials and would involve local stakeholders. The decision must be technically sound and allow officials to defend the decision as protective of public health and the environment. The decision might involve using existing capacity for solid or hazardous waste, reopening closed facilities, or constructing new capacity. This type of decision also needs to be part of the planning process.

Mr. Tupin described the scenario that occurred in Chernobyl in 1986. The Chernobyl Nuclear Power Plant suffered catastrophic failure (Level 7 on the International Nuclear Event Scale) as an explosion and fire breached containment and spread radioactivity into the atmosphere and around the world. Several dozen emergency “liquidators” (also known as responders) working to put out the fire died from the effects of radiation. He described the contamination zones, the radionuclides released, and the populations impacted. Over 140,000 square kilometers (km^2) were contaminated above 1 curie (Ci) per km^2. As of 2000, ~350,000 people had been resettled from areas exceeding 5 Ci/km^2; however, ~4.5 million people were living in contaminated areas above 1 Ci/km^2. A permanent exclusion zone covering about 4,300 km^2 in Ukraine, Belarus, and Russia was established. Eight thousand (8,000) km^2 of agricultural land and 7,000 km^2 of timber land have been removed from production. As far as waste management, there was limited effort to decontaminate except to support reactor decommissioning (even in populated areas). More than 1 million cubic meters (m^3) of waste was generated from rubble, debris, and soil.

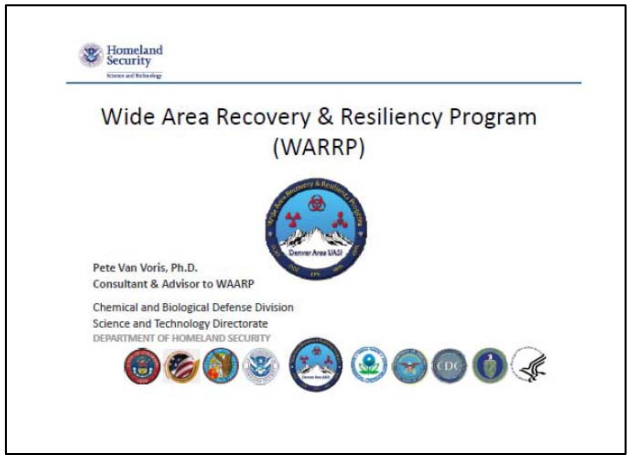
The final scenario that Mr. Tupin described took place in 1987 in Gioânia, the capital and largest city of the Brazilian state of Goiás. An abandoned teletherapy source containing 1,375 Ci of Cs-137 was removed for salvage as scrap metal. The source was breached and the radioactive cesium chloride (CsCl) powder was spread by the salvage workers and their children. The result was contamination of people and property. Four people died, 28 had radiation burns, and 29 others were exposed. Radiation levels were measured at 0.4 Sv per hour (40 rem per hour) at 1 meter from the ground in the salvage yard. This scenario may be the closest known incident comparable to an RDD attack, in that many people were exposed without any warning or knowledge, and radioactive material was spread throughout an urban area. The incident cleanup found 85 houses to be contaminated, of which 41 had to be evacuated; seven residences as well as numerous other buildings had to be demolished. Topsoil was removed from large areas and total waste generated was ~3,500 m^3 (about 150,000 times the volume of the original source). Authorities screened many people who were not exposed, which generated a widespread fear and stigma associated with the incident.

Mr. Tupin said waste from the incident was categorized and segregated for disposal. Two near-surface repositories were constructed ~23 km from Goiânia, near the original temporary storage site. The Great Capacity Container for Group I (short-lived) waste received about 40% of the total volume, while the Goiânia Repository for Groups II – V consisted of more extensive engineered barriers. Mr. Tupin commented that a great deal of time is required to develop disposal capacity options even for even a relatively small and contained amount of waste

(3,500 m^3), which is not inconsequential but well within the capacity of commercial disposal facilities and much smaller than one would expect from an actual RDD event.

WARRP 101

Peter VanVoris, Ph.D., VanVoris and Associates, LLC



Dr. VanVoris provided an overview of WARRP and discussed WARRP goals and objectives. He then described the collaborative program with the UASI and State of Colorado, whose goal is to develop solutions to reduce the time and resources required to recover wide urban areas, military installations, and other critical infrastructures following a catastrophic CBR incident. Stakeholders consist of interagency partners, including federal/state /local/tribal governments, the military, private industry, and non-profit organizations.

Dr. VanVoris said that a program predating WARRP, called the Interagency Biological Restoration Demonstration (IBRD), had a similar set of goals and objectives. The IBRD consisted of an interagency partnership in the Seattle, Washington, region. Its goal was to reduce the time and resources required to recover and restore wide urban areas, military installations, and other critical infrastructures following a biological incident. Similar objectives included establishing civilian and military coordination, developing guidance and decision frameworks, and demonstrating technologies. Another program he described was BioNet, a cooperative program between DHS and the Defense Threat Reduction Agency with a vision and objectives similar to IBRD and WARRP. BioNet sought to improve the ability of a major urban area in the United States to manage the consequences of a biological attack on its population and critical infrastructure by integrating and enhancing currently disparate military and civilian detection and characterization capabilities. The outcome was a unified consequence management approach. The BioNet program selected San Diego as the pilot city for developing and demonstrating enhanced consequence management capabilities. The BioNet program engaged a variety of stakeholders, including both civilian and military organizations in the San Diego area, to ensure that the BioNet program was based on a full and realistic picture of biodefense operational needs in a major metropolitan area.

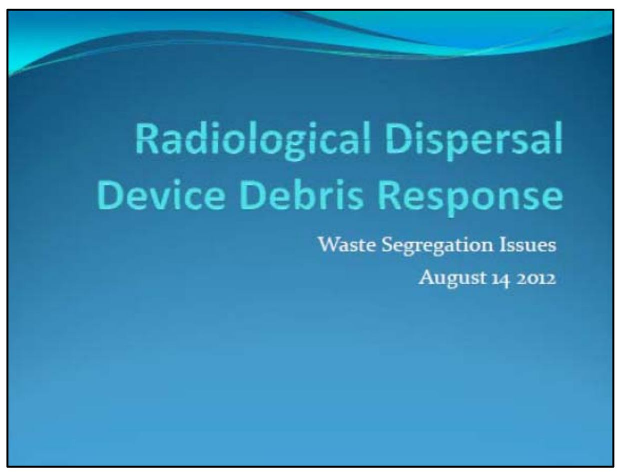
Dr. VanVoris then focused his presentation on WARRP, highlighting the planning guidance, technical reports, and technology solutions that have been generated under WARRP. From an operational context, one WARRP metric is to reduce the time and resources required for recovery following a catastrophic CBR incident. The goal is to be able to recover in six months, while current estimates prior to IBRD and WARRP were 18+ years. Additional WARRP metrics include the following three types of positive impacts:

- Efficiency Impacts measured via a significant cost savings (millions or billions of dollars) for wide-area environmental remediation of CBR incidents. This results from more effective, scalable, and improved technologies and methodologies that are now made available for sampling, decontamination, and operation.
- Capability Impacts measured by reduced risks for wide-area recovery planning, which in turn increases performance for the rapid recovery of critical infrastructure.
- Finally, the Return-on-Investment Impact measured from the "customer viewpoint," which is immediate to short term for the case of a wide-area incident and relatively short term for planning guidance and for public health monitoring and surveillance.

Dr. VanVoris also described a transition plan and project status on the several activities still ongoing under WARRP.

He concluded his presentation by reviewing several radiological attack scenarios, ranging from a medical waste spill or transportation accident to a terrorist-focused dirty bomb or terrorist delivery of a full yield "loose nuke."

Waste Segregation Issues Facing State and Local Governments
Dave Erickson, Denver Environmental Health



Mr. Erickson described a simulated RDD scenario at the U.S. Mint in downtown Denver, Colorado. The scenario assumes significant debris is generated, structures are damaged (no fires), and levels of radiation are elevated (up to 5 rem) extending several hundred feet from the explosion. He noted that residual hazards exist from contamination of buildings, debris, turf and trees, vehicles, and white goods.[4] Issues likely to arise include the handling of large volumes of collected vegetation and building debris, storage of collected contaminated debris, waste volume reduction, treatment of cesium-contaminated waste, and waste storage and disposal. Mr. Erickson expected that remediation methods employed would include removing ground cover and the top few inches of soil, washing roofs and walls (and attempting to contain the water), removing contaminated debris to temporary debris storage sites, imposing institutional controls, and repairing structures/infrastructure damaged by the RDD event.

Mr. Erickson described Denver's experience with hazardous debris, which includes asbestos in soil and buildings, that could parallel cesium-contaminated debris. He explained that Denver had previously had to remove radium tailings from approximately five miles of Denver streets. The

[4] The term "white goods" refers to appliances such as refrigerators, ranges, water heaters, freezers, air conditioners, washing machines, clothes dryers, dehumidifiers, dishwashers, and other similar domestic and commercial large appliances.

road base was excavated and transported to Grandview, Idaho; Clive, Utah; and Deer Trail, Colorado for disposal. The required cleanup level was less than 5 picocuries per gram (pCi/g) Radium-226 on the surface. Institutional controls for these cleanup sites were not feasible.

Mr. Erickson also highlighted some of Denver's asbestos-removal techniques (e.g., soft sided waste containers called "burrito bags") and discussed Denver's options for temporary debris management sites (25 locations), with final disposal at the Denver Arapahoe Disposal Site.

Finally, Mr. Erickson highlighted some of the data gaps or concerns facing his organization with respect to debris storage and disposal. The primary concern is that Denver's Debris Management Plan is silent on RDDs. He cited the small number of local experienced personnel and that cleanup of private property will require both assistance and oversight. An additional concern is temporary radioactive debris storage. There is limited capacity for storage and segregation of radioactive debris, and its presence would likely result in resident opposition. No local capacity for permanent disposal of contaminated debris exists, but the city has an agreement with Utah for radioactive waste disposal. The entire concept is expensive to implement and makes transportation difficult.

Segregation Technologies
Rick Demmer, INL
Discussion facilitated by Rachel Sell, Battelle

Before Mr. Demmer began, Ms. Sell distributed a copy of the preliminary results from the literature review, one of the other tasks associated with the WARRP Decon-13 Waste Screening project. She noted the literature review would be expanded to include topics discussed during this session. During the discussion, Ms. Sell said she would capture SME participant comments and ask for feedback on the technology features after Mr. Demmer reviewed each technology.

Mr. Demmer opened his discussion by describing the scenario (i.e., Scenario 11) and introducing the major methods of large-scale characterization/remediation. He also presented case studies describing the technologies that had been used.

Mr. Demmer said that as part of the Idaho Nuclear Technology and Engineering Center contamination event that occurred in April of 1992, small flakes of radioactive material were dispersed to a small area north and east of the 250-foot tall central off-gas stack. A sudden release of steam from a stripping tower was accidentally directed through the stack and "scoured" the flakes up and out of the stack. The site was locked-down for about 6 hours until it could be confirmed that evacuation routes were clear of contamination. Eberline manual survey (*in-situ*) instruments coupled with high efficiency particulate air (HEPA) vacuums were used to identify and characterize hotspots. Using this approach, which involved approximately 100

workers, about 50 acres of contaminated area was characterized in two weeks, resulting in several tons of waste. He also said automated survey instruments exist that are equipped with computer-generated mapping capabilities and can be mounted on unmanned vehicles. An SME participant said automated techniques, while scientifically driven, may have a negative public perception because it is impersonal to see an unmanned technology operate in one's community compared to a manual survey that has a human presence.

SME participants agreed this approach seems like a viable option to consider. EPA has demonstrated ground-based and airborne wide-area surveys. Once surveys are complete, cleanup strategies can be implemented (i.e., roof removal, scarification). An advantage of using manual survey instruments is that public perception is positive because there is a "presence" of a person operating the device.

Mr. Demmer described another technology that was used at the Painesville, Ohio, Diamond Magnesium facility. The 30-acre facility recycled radioactive scrap from 1951-1953. The soil at the site was contaminated and initially 9,400 cubic yards (yd^3) were removed followed by another 25,000 yd^3 as more contaminated soil was identified. In 2007, EPA excavated the contaminated soil at the site and the Segmented Gate System (SGS) was used for waste segregation. A SGS is a radioactive soil waste minimization system using a series of conveyer belts that pass excavated soil under radiation detectors. He noted that the SGS was also utilized at Johnston Atoll from 1990-1998 and had an overall removal efficiency of 98%.

One SME participant noted that SGS works great for soil, but not for biomass or other debris. A disadvantage of this technology could be the perception that treated material might be reused. A participant asked whether Denver would be an easier location to implement SGS compared to a more densely populated metropolitan area. The response was that Denver would be an easier location to implement the SGS in lieu of a more densely populated city such as Chicago or New York City. The subject of cost also was discussed among SME participants; with projected estimates ranging from $100,000 to $1.2 million (the former equating to simply renting a currently operable SGS to the latter of completely building a new one, as was the case at Johnston Atoll, where costs included SGS + equipment, including front loaders).[5]

Mr. Demmer said that for the Goiânia scenario, personal items were decontaminated and everything else from the neighborhood was demolished, or dug up and removed. This fairly low-tech approach dubbed "digging and hauling" would be considered baseline. SME participants said this approach would be a necessary step regardless. Another comment was that this would be very costly to implement and that transportation and public resistance to hauling would be an issue.

Mr. Demmer reviewed the cleanup strategies employed for the Chernobyl accident. He said that the typical remediation used was "triple" dig or plow (the use of shovels to dig up the surface dirt and rebury it well below the surface while bringing fresh topsoil to the surface), but a suite of other techniques such as grass cutting, vacuum sweeping roads, and soil removal were also used. SME participants questioned whether this technique would be realistic in an urban area and

[5] The estimated cost would have to be verified for an RDD incident in the Denver area.

whether it would create a subsequent groundwater issue. Other disadvantages to “triple” digging or plowing would be access (i.e., gaining access to sections of the city in a rapid manner and with large equipment) and timing issues (i.e., when to remediate).

Mr. Demmer presented a table that showed cost estimates and throughput for each technology, which garnered a lot of discussion among SME participants. One concern raised by the participants was that equal importance was given to all of the technologies, when in reality each waste method and technology would be applicable during different times of cleanup and recovery. Some of the information presented in one of the tables was considered very subjective and potentially useful only under certain circumstances.

Ms. Sell asked for participants to suggest other technologies to consider. SME participants said that biomass strategies should be considered, including incineration, composting, and landfilling. Other SME participants suggested looking at turf or sod cutters and said turf/sod cutters would be more ideal (look at what Japan is doing), while others commented that Denver may have limited applicability for this technique because of roots and rocks in the soil, which may lead to increased costs.

Other participants suggested looking at street sweepers, leaf/brush/tree removal technologies, and selective removal of vegetation. A discussion about dust suppression requirements for these systems followed.

Another suggestion was to consider plasma arc vitrification as it was used in Russia for animal carcass disposal.

An SME participant raised the question of secondary waste generation and asked whether mobile water treatment facilities are available.

Another SME participant asked if lawn mowers could be retrofitted with HEPA vacuums. An encapsulant or fixative may need to be added to the system. This idea could be field tested.

Criteria for Evaluating Segregation Technologies
Rick Demmer, INL
Discussion facilitated by Rachel Sell, Battelle

Mr. Demmer described the criteria to be considered for evaluating segregation technologies. He noted that criteria can be subjective or objective and that they can be impacted by several factors, including: (1) type of contaminant (radionuclide, chemical nature and physical form); (2) type of substrate (building material type and configuration); (3) functionality in different weather conditions; and (4) desired endpoint cleanup level. He presented an example

criteria list for decontamination, and then presented a subset of draft criteria that would be applicable for RDD cleanup, shown in Figure 1.

Ms. Sell asked SME participants to suggest additional criteria to consider beyond the ones that are presented in Figure 1. Additional criteria suggested included availability (how easy is it to obtain/access the technology) and time required to implement. These two criteria were added to the primary criteria listed on the left-hand side of the chart that Mr. Demmer presented, which included technical performance; safety, health and environmental considerations; and cost.

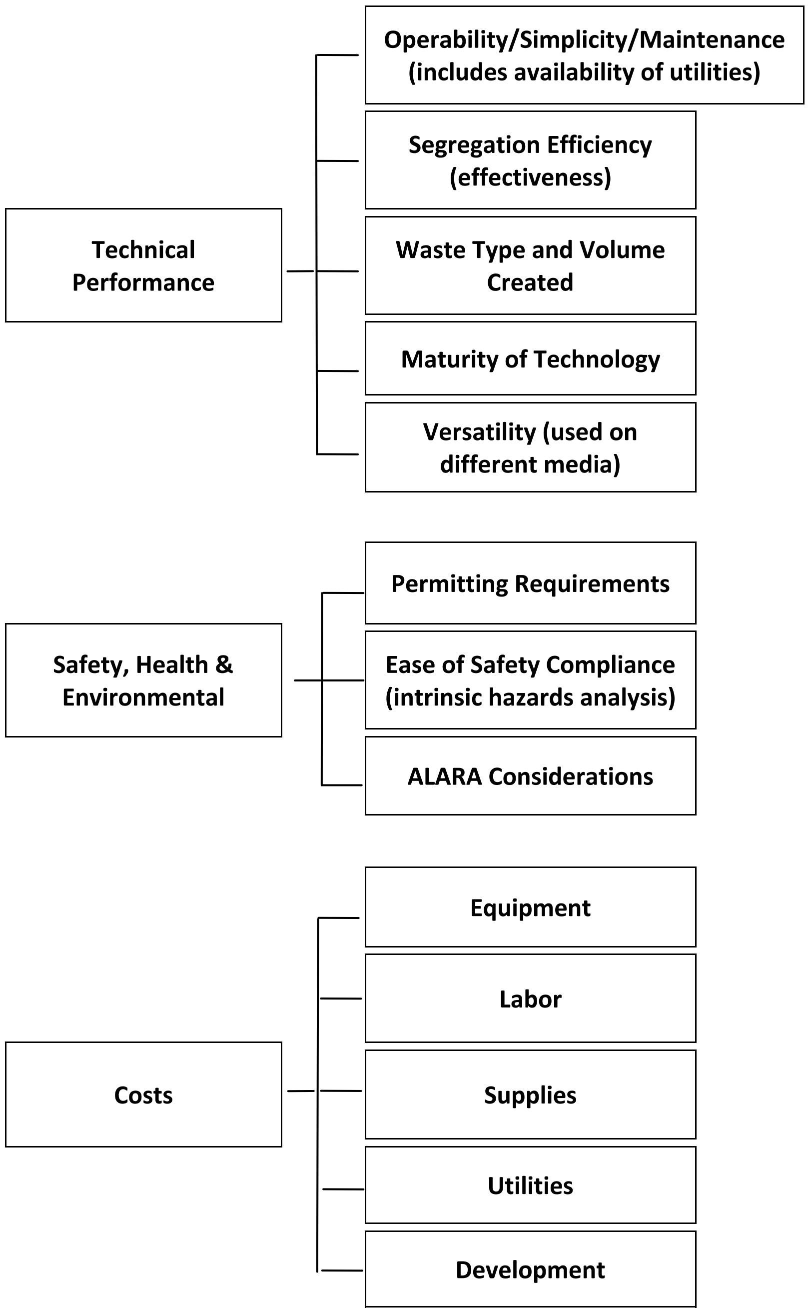


Figure 1. Criteria to be considered for evaluating segregation technologies.

Following this discussion, Ms. Sell gave each SME participant a copy of a Technology Scoring Matrix, presented below in Table 1, and asked them to evaluate the technologies for each of the five primary criteria (the impact each might have regarding liquid waste production was added subsequent to the Day 1 discussion). Mr. Demmer described the process to be used to score each criterion. Ms. Sell said the results of the exercise would be compiled and presented the following day, with the goal of finalizing a criteria list by the end of the SME Meeting.

Wrap Up – Review Expectations for Day 2
Rachel Sell, Battelle

Ms. Sell thanked the presenters for all of the great discussion among all SME participants as part of Day 1. She explained what would be discussed on Day 2 and adjourned the meeting for Day 1.

3. SUMMARY OF DAY 2, AUGUST 15, 2012

Welcome
Paul Lemieux, EPA, NHSRC

Dr. Lemieux welcomed participants back to the second day of the meeting and expressed his appreciation for everyone's feedback from the previous day. He said the goal for Day 2 was to have an SOG outline completed by the time the meeting adjourned.

Rank Technologies Against Finalized Criteria
Rick Demmer, INL
All (discussion facilitated by Sell)

Mr. Demmer began the session by explaining that he incorporated SME participant feedback from Day 1 and recategorized the technologies and methods. The technologies would be categorized by *in-situ* remediation ("characterization"), *ex-situ* removal ("mitigation"), and *ex-situ* (after removal) treatment/disposal ("waste management").[6] SME participants provided additional input as to whether this recategorization was appropriate. They felt that disposal as a waste management option needed to come off the list since it was assumed that disposal was a "given" and, therefore, shouldn't be listed and scored. They also suggested adding liquid waste (i.e., the amount of water generated during decontamination) to the criteria list. What confounds the issue is that normal stormwater and other weather events generate contaminated water in addition to the water produced by decontamination activities.

After the discussion, Ms. Sell distributed a blank table (i.e., without colors) similar in structure to Table 1, then asked SME participants to score each technology against each criterion and assign it a low/not advantageous (red), medium/neutral (yellow), or high/advantageous (green) designation. Minimal generation of liquid waste was considered advantageous. Ms. Sell explained that the results would be compiled and presented in the SME Meeting summary. Table 1 summarizes participant scoring and is presented in no particular priority order.

[6] It is acknowledged that characterization and remediation are two separate actions; however, they are closely tied together, and for the purpose of discussion were categorized this way during the SME Meeting.

Table 1. Technology Scoring Matrix

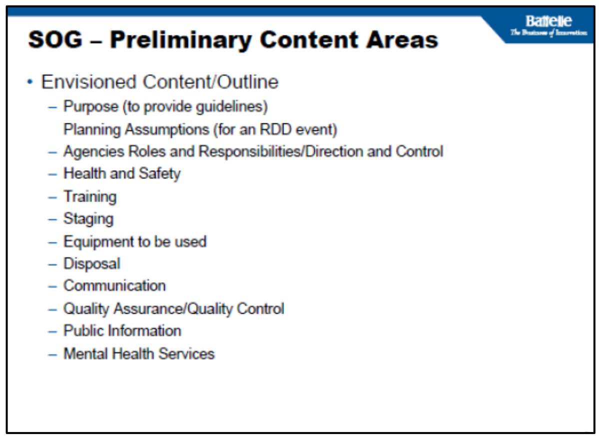
Alternative	Safety, Health & Environmental	Time to Implement	Technical Performance	Availability	Costs	Liquid Waste
***In-situ remediation*[7]**						
Manual survey	Yellow	Green	Green	Green	Yellow	Green
Automated survey	Green	Yellow	Yellow	Yellow	Yellow	Green
Survey/dig (plow)	Yellow	Red	Red	Green	Yellow	Green
Ex-situ removal						
Lawn mowing	Red	Green	Red	Green	Green	Green
Parking lot washer (HEPA)	Green	Green	Yellow	Yellow	Yellow	Yellow
Sod cutter	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Scarifier	Yellow	Yellow	Green	Yellow	Yellow	Green
Large-scale dig and haul	Yellow	Yellow	Green	Yellow	Yellow	Yellow
Selective removal of vegetation	Yellow	Yellow	Yellow	Green	Green	Yellow
Ex-situ (after removal) treatment/disposal						
Segmented gate system	Yellow	Yellow	Green	Red	Yellow	Yellow
Soil washing	Yellow	Yellow	Yellow	Yellow	Yellow	Red
Composting	Yellow	Yellow	Yellow	Green	Green	Green
Plasma arc vitrification	Yellow	Red	Green	Red	Red	Green
Incineration	Yellow	Yellow	Yellow	Yellow	Yellow	Green

Low/Disadvantageous	Red
Medium/Neutral	Yellow
High/Advantageous	Green

[7] Vacuuming and digging both generally imply removal; however, these types of techniques could be coupled with manual or automated survey. Manual or automated surveys may assist remediation by helping to determine what needs to be remediated and what can be left alone or, as in the case of soils, redeposited.

Participants appeared to be mostly in favor of technologies that are available, are not expensive, and generate minimal liquid waste. Two examples of these kinds of technologies would be the manual survey/vacuum and “dig and haul”. Those techniques are also likely to have been used often in the past, thereby offering the advantage of user experience. However, results also show that SME participants may be cautiously optimistic about other techniques (e.g., soil washing, SGS, lawn mowing) which potentially provide improved cleanup efficiency. These results provide insight into the barriers that may exist from an applications standpoint and the work that needs to be done to gain acceptance of the technologies.

Standard Operational Guideline – Preliminary Outline and Discussion of Content
Rachel Sell, Battelle; All (discussion facilitated by Sell)



Ms. Sell said the final objective of the meeting was to develop an outline for a draft SOG. The SOG will describe the use of selected waste screening technologies for minimization of waste from an RDD event or other radiological incident. The resulting SOG is expected to be included in WARRP planning documentation that will be developed to address waste triage, staging, disposal, and quality assurance/quality control. The SOG will likely provide an opportunity for any qualified contractor familiar with bulk material radiological detection equipment to be deployed for this activity. Dr. Lemieux added that a goal of the SOG is to give guidance without being too prescriptive.

Ms. Sell presented a preliminary outline for the draft SOG. SME participants provided feedback on each item in the outline. The initial part of the discussion focused on the “why” of the SOG. SME Meeting participants said that the document needs to include an introductory section that explains the purpose and “why” there is a need for the SOG. The concept of expeditious recovery was also part of this discussion.

SME participants said a health and safety section is needed in the SOG to reference regulations, special exceptions, and the role of “self cleanup.” With respect to training, worker and citizen group training guidance was mentioned as needing to be covered. SME participants also suggested that an annex be added that contained descriptions of the technologies to be considered.

SME participants suggested several resources which could be consulted for populating the draft SOG, notably the www.ready.gov website. They said that Superfund waste management guidance materials should be consulted as well as asbestos debris management guidance. A U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service decision tree was also suggested as a resource. Additionally, there is a Hanford SOG for dealing with tank

explosions that may offer some ideas. SME participants offered to forward ideas or examples after the meeting.

The following table summarizes the final draft outline that was agreed upon during the SME Meeting.

Section No.	Standard Operational Guideline (SOG)
1	Purpose (include perspective as to why)
2	Planning Assumptions (for an RDD event)
3	Agencies Roles and Responsibilities/Direction and Control
4	Operational Concepts
5	Equipment to be used
6	Health and Safety (worker and environmental)
7	Training
8	Waste Management
9	Public Information
10	Quality Assurance/Quality Control
11	References
12	Annex – Technology Descriptions

Discussion of Path Forward
Rachel Sell, Battelle

Ms. Sell thanked participants for attending the SME Meeting and for all of their input and contributions to the discussion. She also presented a draft schedule (listed in Appendix B) for upcoming project deliverables for the Waste Screening project. She told participants they would be provided with the SME Meeting summary and with copies of the presentation.

Closing Remarks
Paul Lemieux, EPA, NHSRC

In his closing remarks, Dr. Lemieux thanked the presenters and all other participants who had contributed to the meeting discussions. He felt that the SMEs came to realize that rather than focusing on a single technology or two, a technology toolbox approach should be followed to identify the important considerations of different technology options, realizing that each one might potentially be used depending on the situation.

Dr. Lemieux noted that an optional component of the Waste Screening project may be to participate in an operational demonstration during the WARRP Capstone meeting September 13-

14, 2012, in Denver. He said the WARRP Capstone event may be an opportunity to demonstrate one or two of the “lower-tech” approaches in front of a larger audience. Dr. Lemieux envisioned that the operational demonstration would consist of setting up several waste minimization schemes in the parking lot and demonstrating them for attendees of the WARRP Capstone event. These “lower-tech” approaches could include using hand-held survey methods, demonstrating the use of sod cutting as a way to separate highly contaminated material from material with low levels of contamination, and possibly showing ASPECT’s mapping capability by using detection equipment in the parking lot or placing the detector in a vehicle and driving around the area. Based on discussions during the meeting, it appears that the technology for screening soil is currently commercially available and that the EPA has access to the technologies.

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APPENDIX A

List of Participants

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List of Participants for the

U.S. Environmental Protection Agency and U.S. Department of Homeland Security
WARRP Decon-13 Subject Matter Expert Meeting
Waste Screening and Waste Minimization Methodologies Project
August 14-15, 2012
Denver, Colorado

Name	Affiliation	August 14	August 15
Argiz, Armando	Buckley AFB - Office of Emergency Management (OEM)	X	
Benerman, Bill	Denver Environmental Health	X	X
Briese, Garry	Briese & Associates, LLC	X	X
Cleveland, Gordon	USDA	X	X
Demmer, Rick	INL	X	X
Erickson, Dave	Denver Environmental Health	X	X
Evans, Leroy	Defense Coordinating Officer – Region 8	X	X
Graham, Richard	EPA Region 8	X	X
Grove, Glenn	Adams and Jefferson County Hazardous Response Authority	X	X
Hart, James	Denver Fire Department HazMat	X	X
Henderson, Glenn	Wastren Advantage, Inc.	X	X
Hindman, James	Colorado Department of Public Health and Environment	X	
Jablonowski, Eugene	EPA Region 5	X	X
Lee, Charlyss	Energy Solutions	X	X
Lemieux, Paul	EPA NHSRC	X	X
Lloyd, Lisa	EPA Region 8	X	X
Michael, Jim	EPA ORCR	X	X
Moore, Ronnie	US - NORTHCOM	X	X
Mueller, Eric	Buckley AFB	X	

Name	Affiliation	August 14	August 15
O'Connor, Marian	Colorado Department of Public Health and Environment	X	
Patteson, Ray	Sandia (retired), Independent Consultant	X	X
Peterson, Phil	Colorado Department of Public Health and Environment	X	X
Riggs, Karen*	Battelle		
Schultheisz, Dan*	EPA ORIA	X	
Sell, Rachel	Battelle	X	X
Snyder, Emily*	EPA NHSRC	X	X
Steuteville, Bill	EPA Region 3	X	X
Stilman, Terry	EPA Region 4	X	
Torstenson, Jared	Colorado Department of Public Health and Environment	X	X
Tupin, Ed	EPA ORIA	X	X
Van Voris, Peter	Van Voris & Associates LLC	X	X

*Participated via telephone

APPENDIX B

Presentations

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